Vista - market forces trade□offs impacting European ATM performance

Delgado, L., Gurtner, G. and Cook, A.J.

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Vista

Market forces trade-offs impacting European ATM performance

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COCTA Workshop –
Improving Performance in ATM

SESAR JOINT UNDERTAKING

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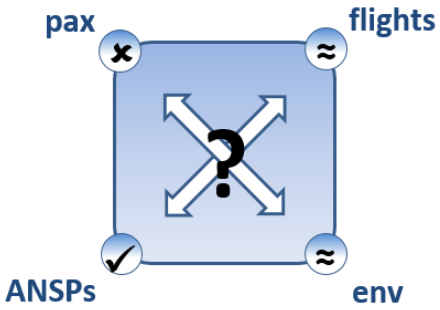
Vista

Overview of presentation

- Objectives of Vista
- Overview of the model
  - principles and construction
  - The tactical layer
    - most mature – presented elsewhere
  - The pre-tactical layer
    - key bridge
  - The strategic layer
    - setting up objectives
- Trade-off analysis
- Discussion
  - not conclusions, rather an open dialogue

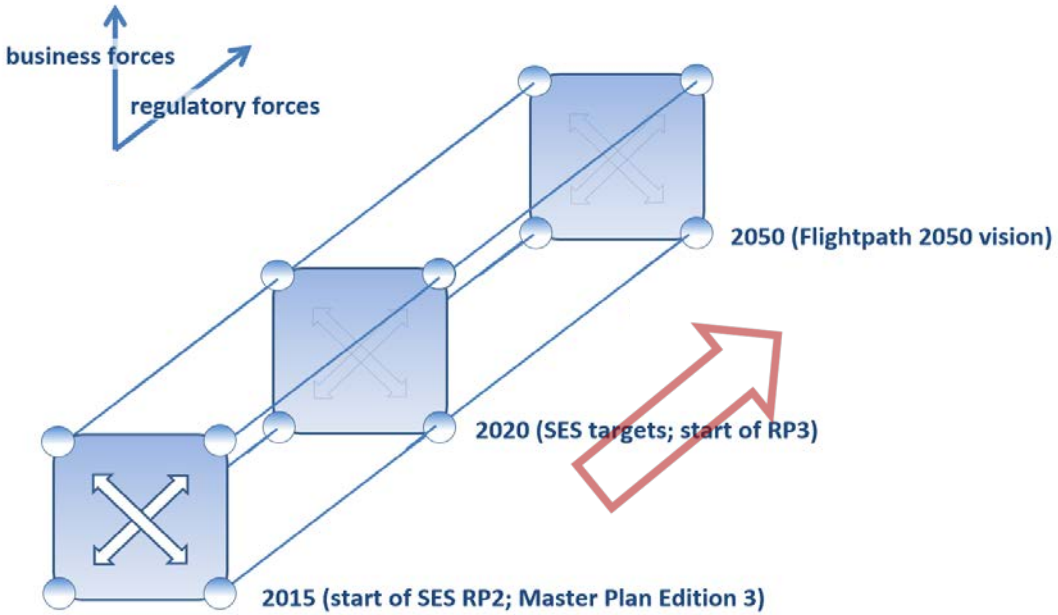
Objectives of Vista

Objectives of Vista



KPIs established for 2015 (all in SES PS, RP2)

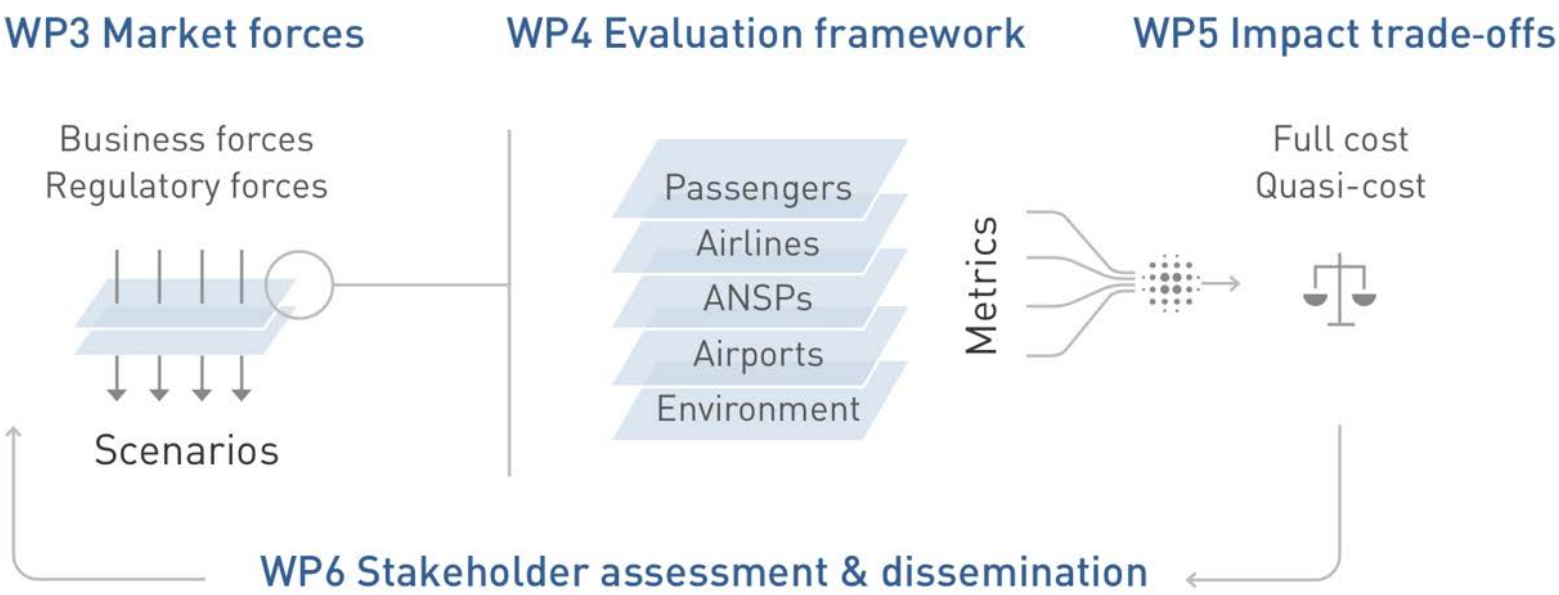
- Current
- 2035
- 2050



Objectives of Vista

- Market/business forces working with/against regulation – unintended consequences?
    - cheaper to cancel a flight? (Reg. 261)
    - delay recovery *v.* emissions impact? (ETS; Directive 2008/101)
    - ANSP delay levels driven *too* low? (SES PS; Reg. 549/2004)
- Impact metrics
    - classical (e.g. average delay) & complexity (e.g. community detection)
    - monetised (e.g. cost of delay) and quasi-cost (NO_x, σ^2_{arr})

Objectives of Vista



Overview of the model

Overview of the model

- The forces/factors considered are subdivided into two main categories:
  - **Business factors (37)**: cost of commodities, services and technologies, volume of traffic, etc. => demand and supply
  - **Regulatory factors (22)**: from EC or other bodies, e.g. ICAO, => 'rules of the game'; some of these are enablers of the business factors
- 85 references consulted

Id	Factor
ROR1	Passenger provision schemes
BTO4	Passengers reaccomodation tool
BTO3	Virtual control centre

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- 85 references consulted
- Further split into 'background' and 'foreground' factors:
  - **Background** (often drive fundamental system evolution)
    - expected small impact on the system

      or

    - highly consensual/less interesting *per se*
  - **Foreground**
    - factors whose impact are to be studied explicitly, in more detail

Overview of the model

Background scenarios

Period	Name	Description
Current	Current	Default
2035	L35: Low economic Low Techno	**Economic growth slow** in Europe **Technological** & operational changes **not supported**
	M35: High economic Low Techno	**Economic growth high** in Europe **Technological** & operational changes **not supported**
	H35: High economic High Techno	**Economic growth high** in Europe **Technological** & operational changes **are supported**
2050	L50	(As per 3035)
	M50	
	H50	

Overview of the model

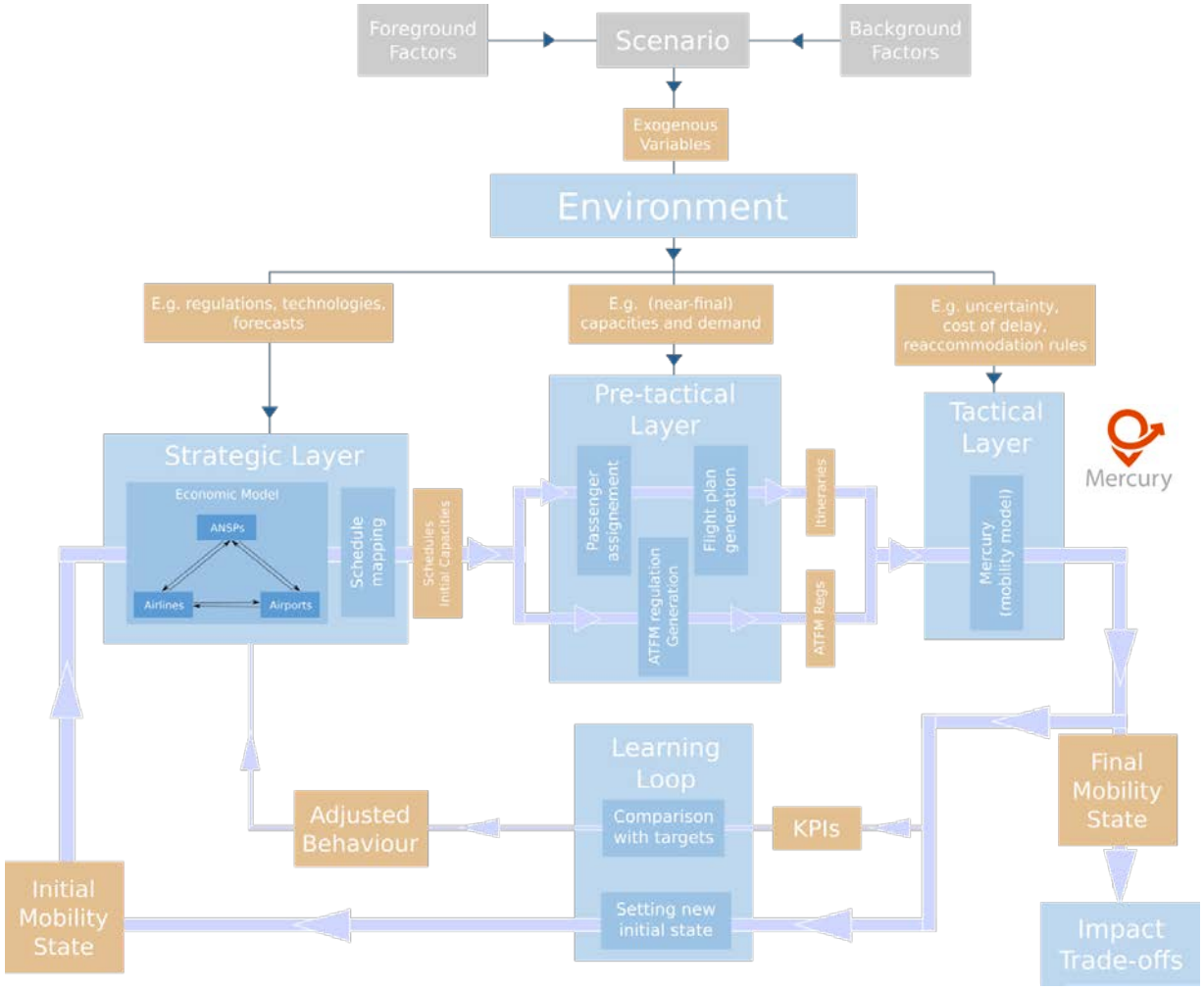
Foreground factors

ID	Business factors
BTS5	4D Trajectory Management
BTS9	Traffic synchronisation
BTO4	Passenger reaccommodation tools
BEO1	Fuel prices
BEO2	Airspace charges
BEO3	Airline business models (output)
BEO4	Smart, integrated ticketing

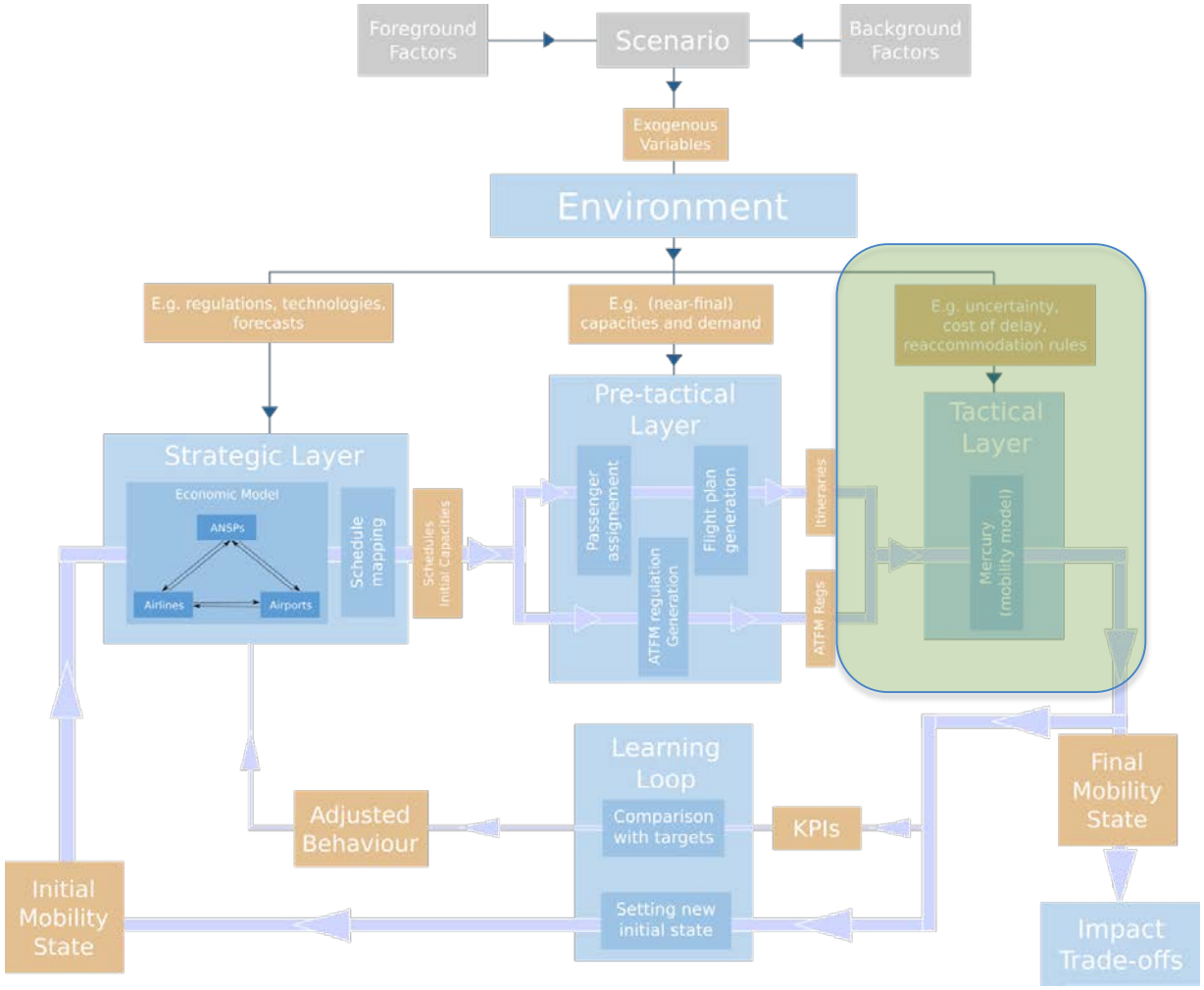
ID	Regulatory factors
ROR1	Passenger provision schemes
ROR3	**Emission schemes**
ROR4	Noise pollution (implicit)
RAD1	Airport slots
RAD2	Regional airport development
RAA1	Airport access
ROR9	Operation of air services

Foreground groups	
EM: Environmental mitigation policies	PF: Passenger focus
RI: Regional infrastructures	SES: Single European Sky

Overview of the model



The tactical layer

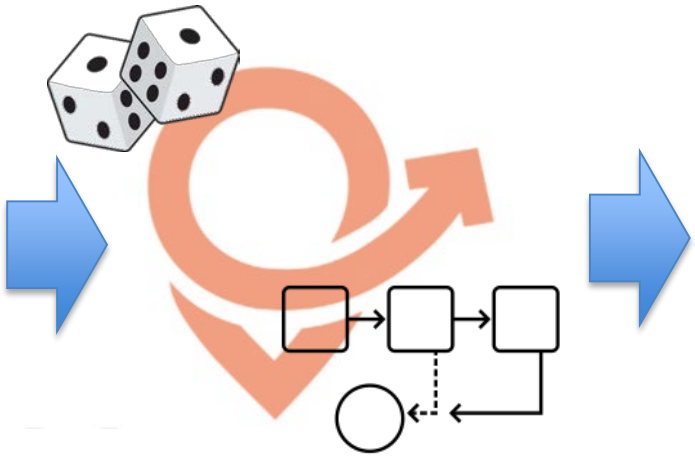


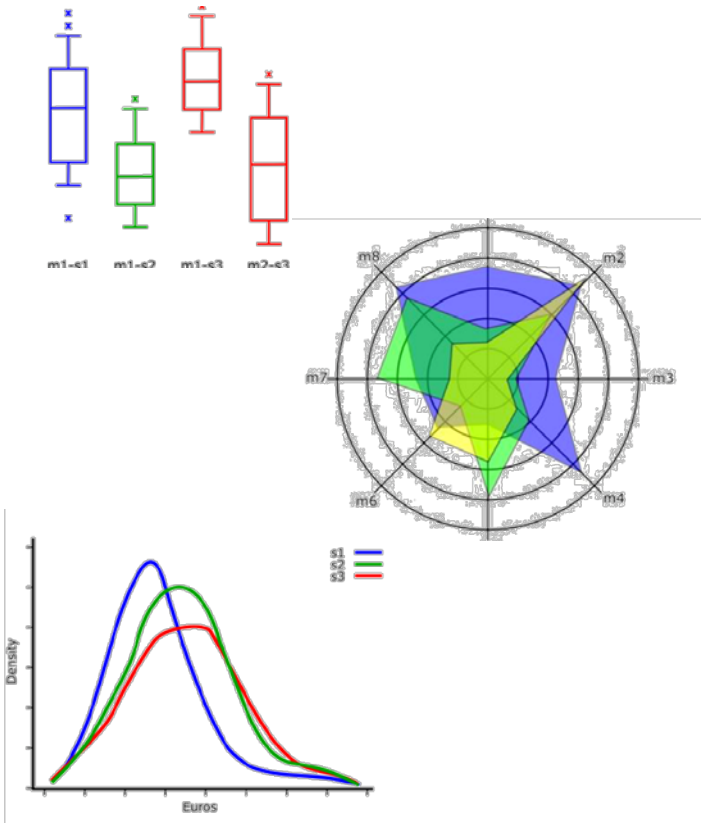
The tactical layer

Flight plans

ATFM delay

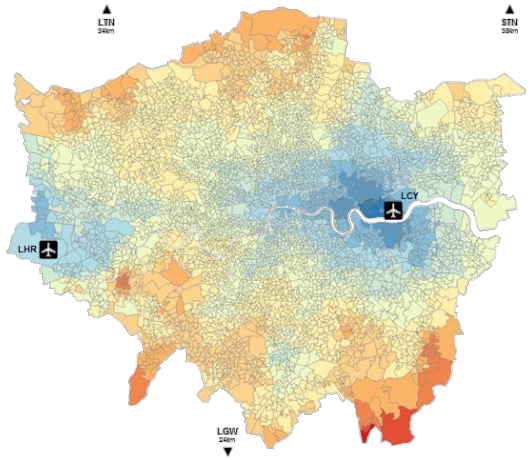
Passengers itineraries

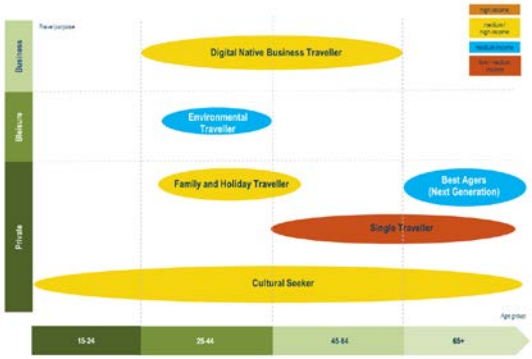




The tactical layer

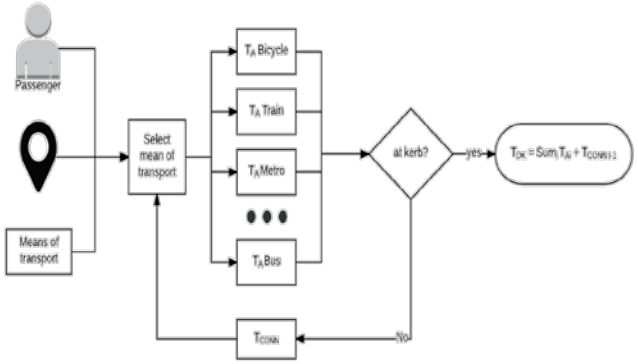
Door-to-door context and 2050 (also courtesy DATASET2050)

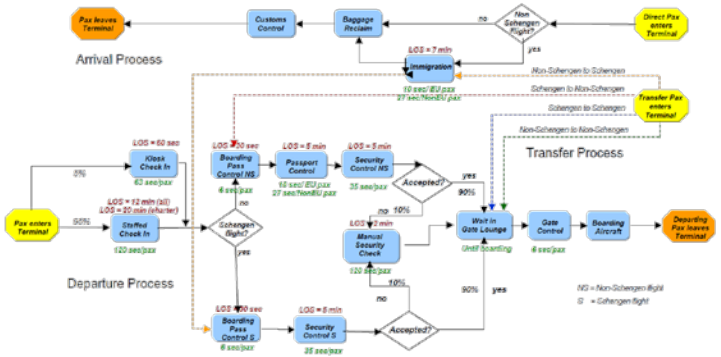




Pax profiles linked with itineraries

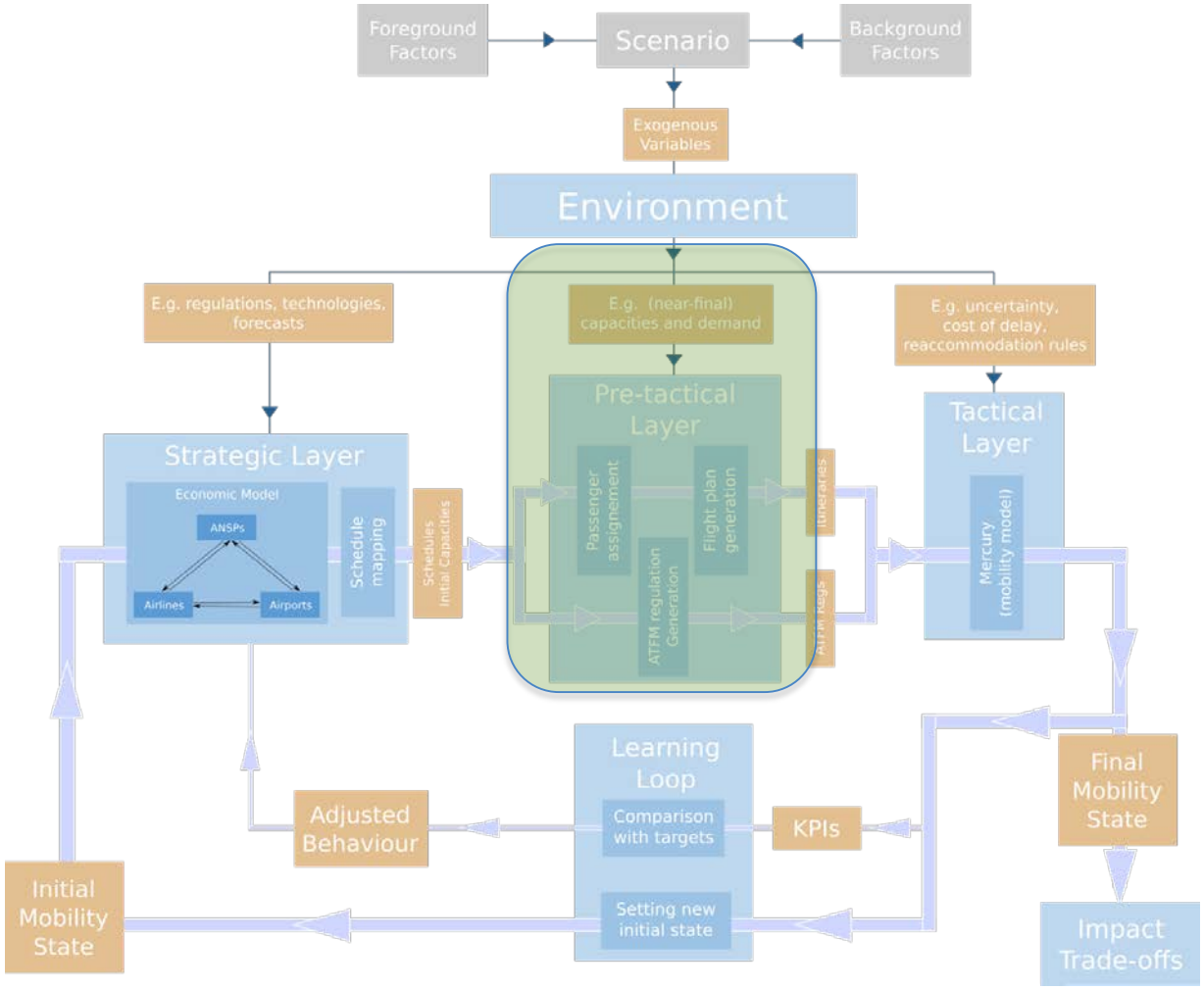
Airport access: data-driven stochastic processes





Confidential access to airport process times

The pre-tactical layer



The pre-tactical layer

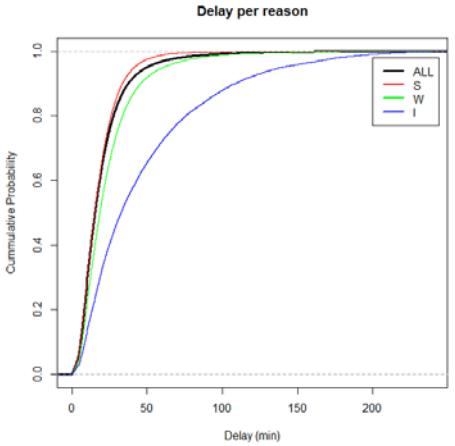
Flight schedules

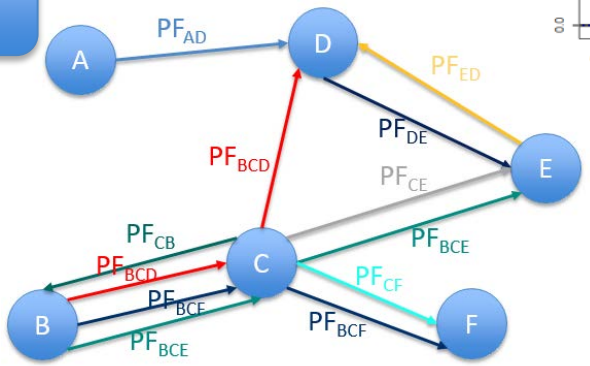
Passenger flows

Flight plans

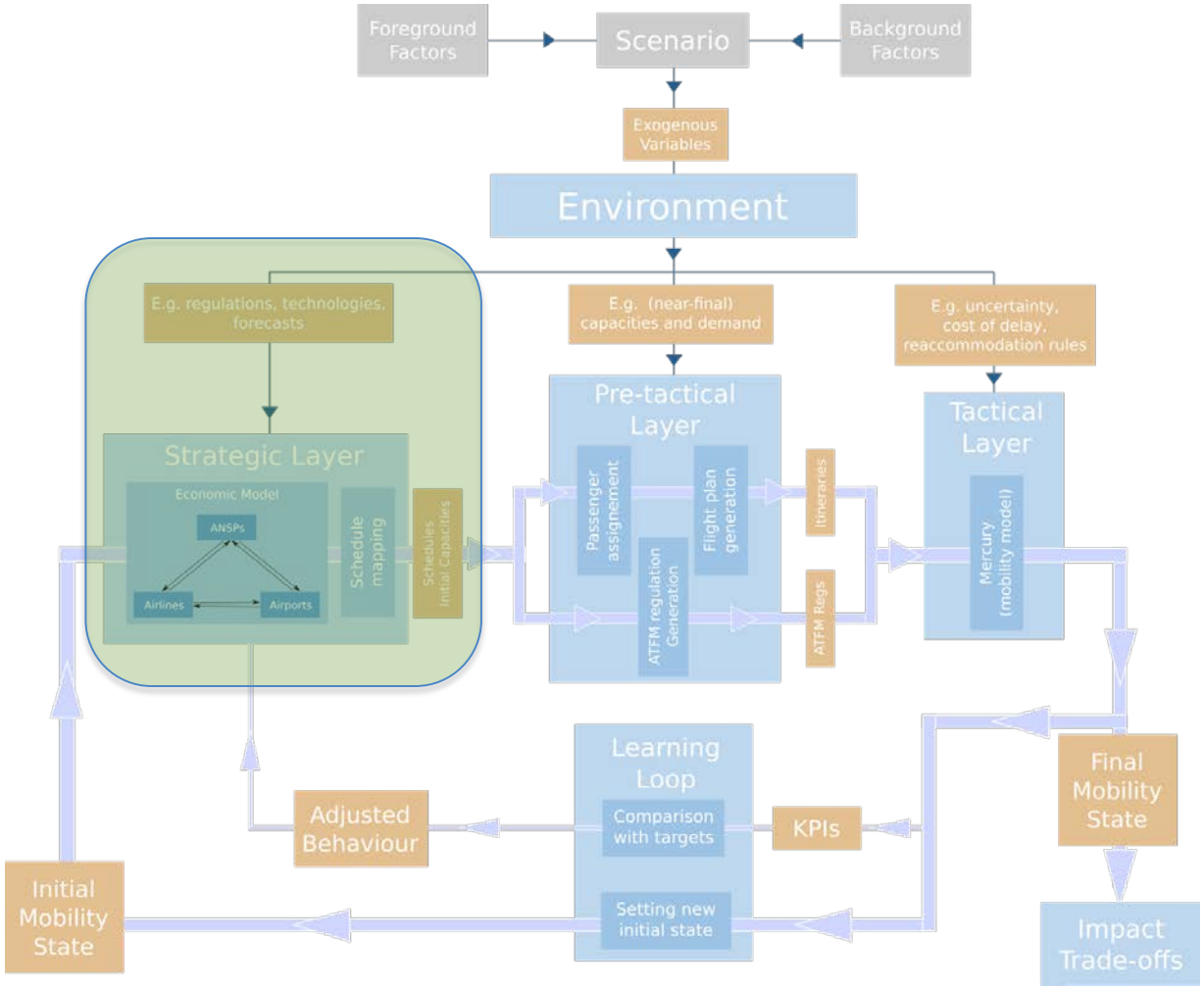
ATFM delays

Passenger itineraries



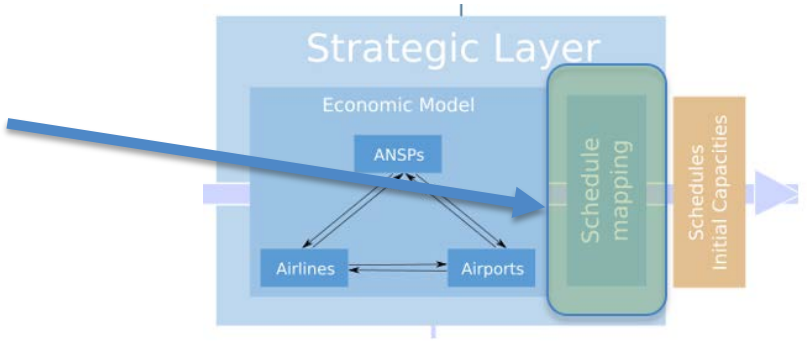


IATA, GDS; MCTs; traffic (high effort)


Foreground Factors
Scenario
Background Factors
Exogenous Variables
Environment
E.g. regulations, technologies, forecasts
E.g. (near-final) capacities and demand
E.g. uncertainty, cost of delay, reaccommodation rules
Strategic Layer
Economic Model
ANSPs
Airlines
Airports
Schedule mapping
Schedules Initial Capacities
Pre-tactical Layer
Passenger assignement
Flight plan generation
ATFM regulation Generation
Itineraries
ATFM Regs
Tactical Layer
Mercury (mobility model)
Learning Loop
Comparison with targets
Setting new initial state
KPIs
Adjusted Behaviour
Initial Mobility State
Final Mobility State
Impact Trade-offs

The strategic layer

- Strategic layer – economic model (takes into account macro-economic factors)
- Desired outputs:
  - main flows in Europe
  - market share of different airline types
  - capacities of ANSPs and airports
  - average prices for itineraries



- Need to take into account:
  - main changes in demand (volume, pax heterogeneity)
  - major business model changes:
    - point-to-point v. hub-based (airlines)
    - competition v. cooperation (ANSP)
    - privatisation v. nationalisation (ANSP and airports)
  - capacity restrictions (congestion at airports; ATCO resource constraints)
  - major changes of commodity prices (e.g. fuel, airport and airspace charges)

The strategic layer

- Turn-based, multi-agent model
- Currently features three types of agents:
  - airport (one agent per airport)
  - airline (one agent per airline)
  - passengers (one agent per OD pair, including all possible itineraries)
  - *ANSPs (coming soon; able to adjust prices after several turns -> AO choice)*

- Each agent has its own objective, with a specific cost function:

AO flight cost function

- fuel
- airport charges
- ATC charges
- delay costs

Pax utility function

- price
- frequency of flight
- income
- delay

Airport revenues and costs

- aeronautical charges
- operating cost of capacity

The strategic layer

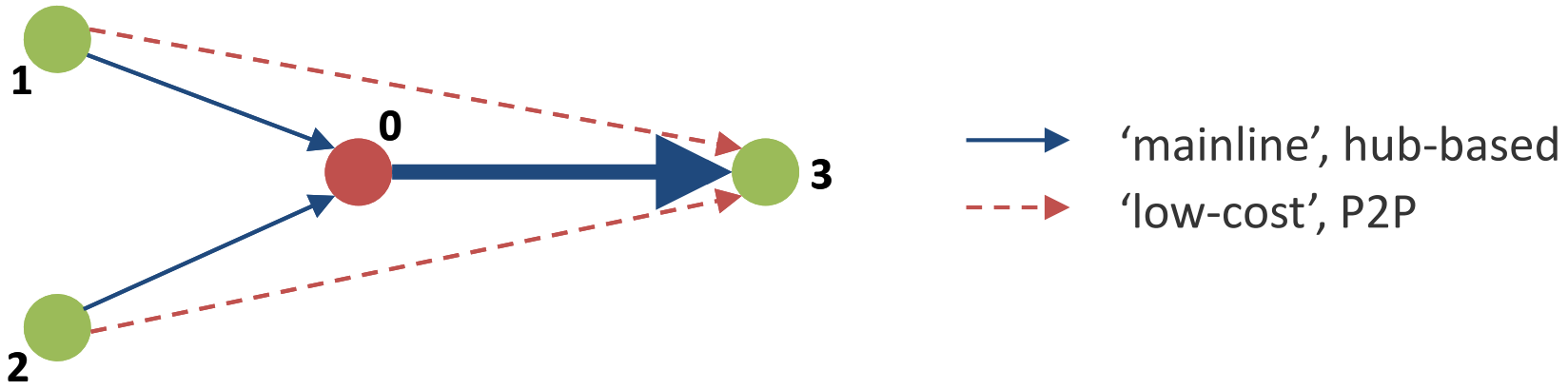
Turns:

- **airlines**
  - estimate prices of each itinerary (based on past prices)
  - estimate delays at airports (based on past delays)
  - choose operated capacity by airport pair (based on est. delays & prices)
- **airports**
  - estimate their traffic
  - decide whether to expand capacity* (based on expected traffic, & costs)
- **passengers** choose between itineraries for given OD pairs
- **selling price** of each itinerary is updated
  - based on balance between supply & demand
- **delays** are updated (based on 'actual' traffic)
- **airports and airlines** compute final profit

* availability lagged by several turns

The strategic layer

Simple scenarios to test / illustrate the model

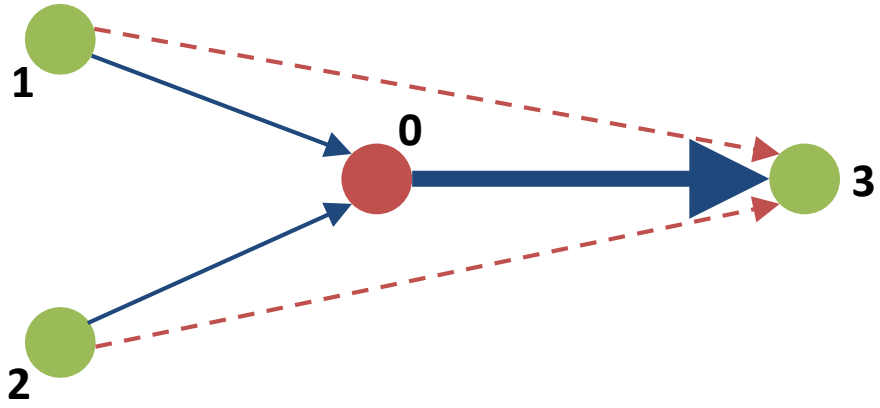


Scenario:

Increased income on high-yield leg: Increase in income of all passengers on the 0->3 leg

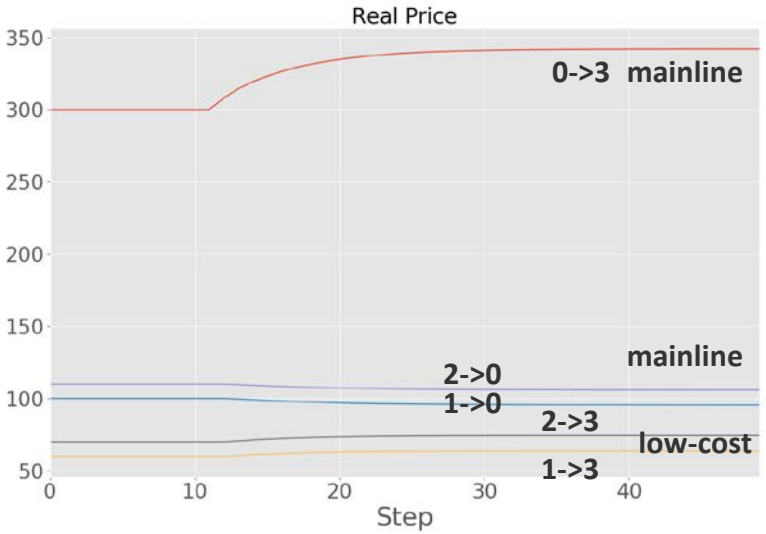
The strategic layer

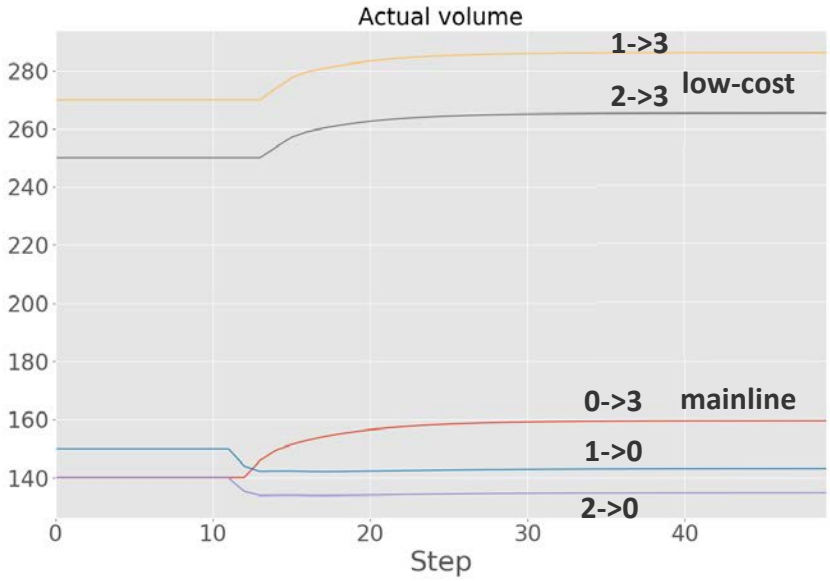
Simple scenarios to test / illustrate the model



‘mainline’, hub-based

‘low-cost’, P2P





The strategic layer

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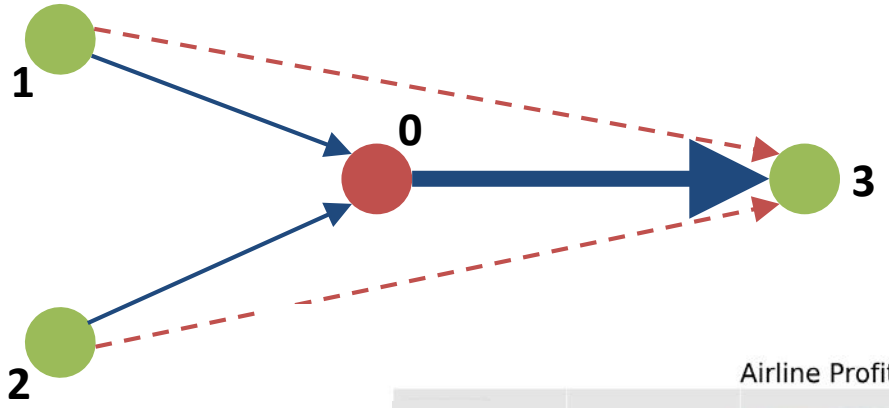

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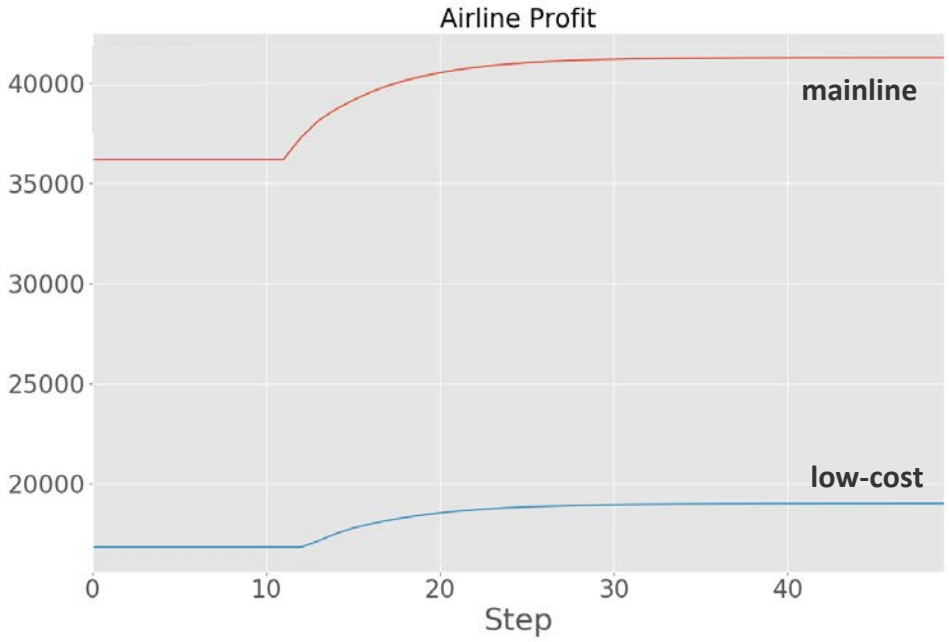

Trade-off analysis

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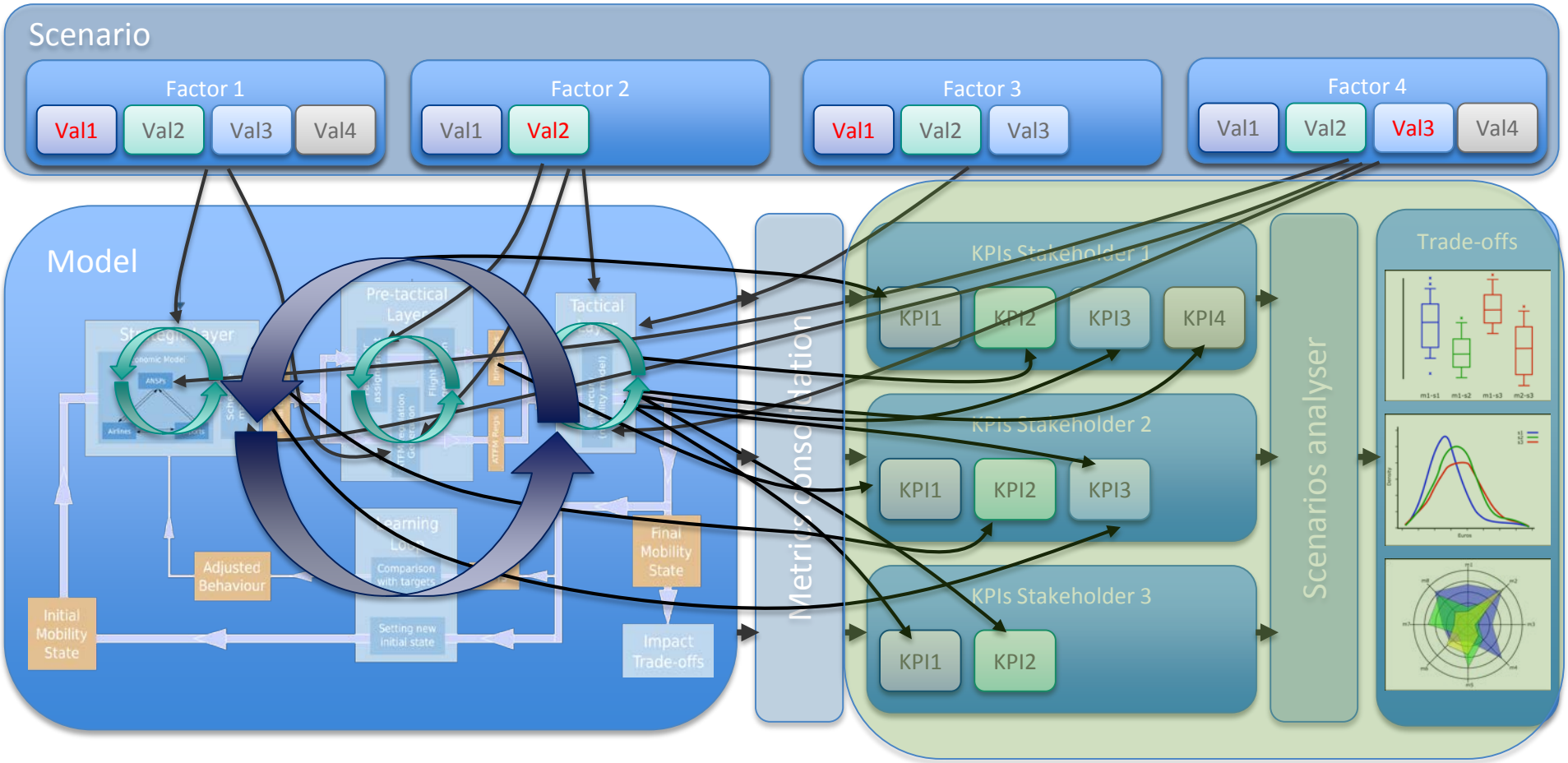

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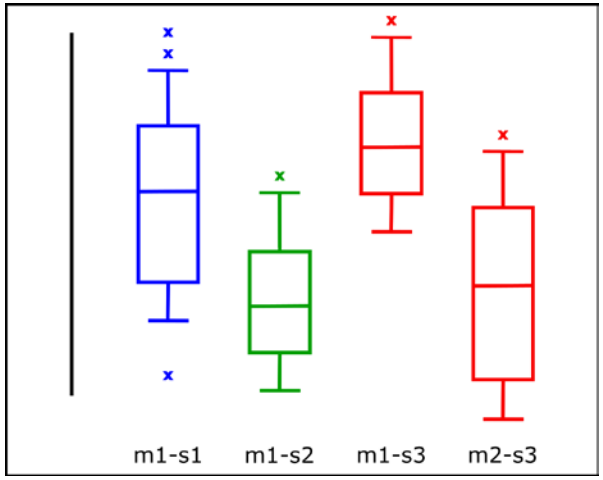

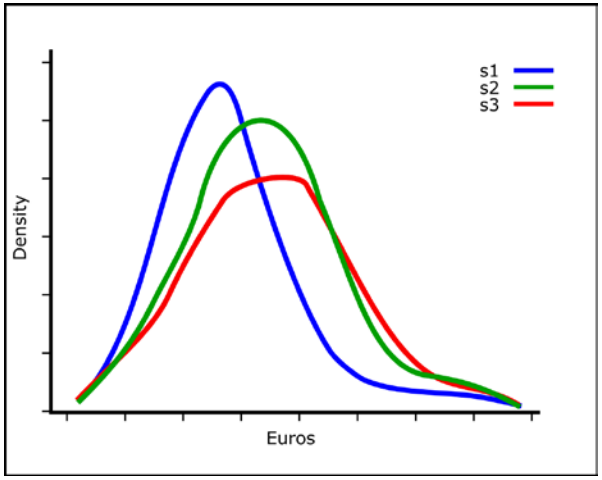

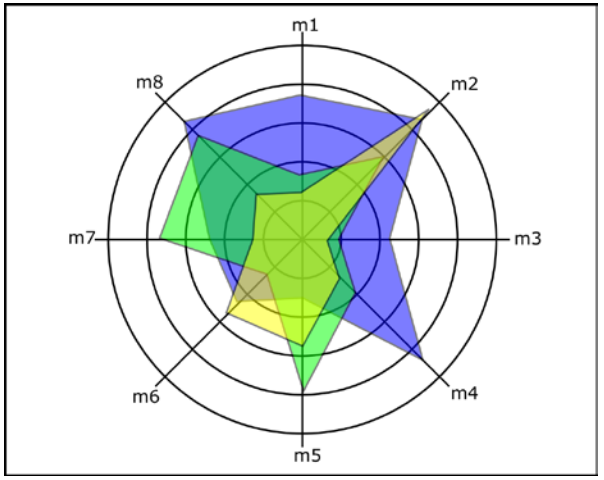

Discussion

Discussion

- Three stage model to capture the impact of factors at each operational level
- The objective of Vista is not the individual value of the metrics per se but the trade-off between them in different scenarios
- Produce trade-offs between metrics for different time-frames, background scenarios and factors

- At this stage in the design process, we'd very much welcome feedback
    - Prioritisation of trade-offs to measure
    - KPIs refinement
    - Archetype definition of stakeholders and their behaviour

- Workshops coming up:
    - Vista workshop – Vienna – 23 October 2017– airspace-research@westminster.ac.uk
    - Performance Work Forum – SJU premises – 07 February 2018

Thank you